

A METHOD AND AN APPARATUS FOR AUTOMATIC IRONING

5 DESCRIPTION

Technical Field

- 10 The present invention relates to a method and an apparatus for automatically ironing clothes items and the like by using only humidity, heat, and air pressure in a container.

Background Art

- 15 It is known that clothes items and the like are usually ironed through the application of moisture, heat, and tension. Other than conventional irons, various devices are available for carrying out this operation having a box shape, in which the garment articles, suitable fitted to mannequins or arranged between clamps and the like, are subjected to impinging hot steam. In this type box like ironing apparatus, the blowing through of hot
- 20 steam and subsequent ironing operations (such as circulation of air in the container, drying, ventilating etc.) and the door closing and opening operations are individually carried out through manual controls. This requires several ironing steps to be subjectively controlled by a person and, thus increasing the time that must be given to the process of ironing by an individual.

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- U.S. Patent No. 3,752,373 and equivalent prior art discloses a cabinet defining an interior region for hanging clothes dewrinkling of which are provided by steam. A fan and heating element is also provided for delivering heated air into the interior region for drying and airing clothes. A significant shortcoming of this type of device is that it does
- 30 not dewrinkle clothes very well.

In order to over come this shortcoming several different devices have been developed, the basic principles of which are to introduce a tool like means to provide an additional

tension on the clothes during ironing process. For example, U.S. Patent No. 5,305,484 discloses a cabinet utilizing weighted bars to provide tension to the clothes to remove the wrinkles in addition to a steam delivery means and a hot air delivery means. However, this type of system is relatively ineffective in dewrinkling the clothes compared to the conventional techniques and stretches the clothes out of shape due to non-uniform tensioning.

U.S. Patent No. 3,480,187 discloses a pressing machine utilizing an inflatable air bag for dewrinkling clothes items. The inflatable bag is dressed with a shirt like garment and inflated so that the garment is highly stretched. While this type of system is inefficient in dewrinkling, it requires plurality of clamps to ensure that the item is held in place when the bag is inflated and is not very practical to use.

U.S. Patent No. 4,493,160 discloses a clothes treatment cabinet wherein shirt-like items are fitted to mannequin-like supports and subjected to steam. However, this system does not provide the desired tension on the item to accomplish dewrinkling.

U.S. Pat. No. 5,815,961 discloses a clothes treating cabinet with inflatable hanger for pressing the shirt like clothes item against the cabinet inner side surfaces. During the dewrinkling cycle, steam is introduced into the interior region while the inflatable hanger assembly is periodically inflated. This type of system has several shortcomings. First, a shirt sleeve support system is still needed because dewrinkling shirt sleeves is a major problem for the devices discussed so far. However, any kind of stretching by means of clamps or cords and the like, is not able to provide satisfactory results as in conventional means of ironing. Second, ineffective dewrinkling cannot be prevented since there is no one to one correspondence between the shape of a clothes item and inflatable hanger.

A need thus exists for a method and a machine for automatically dewrinkling clothes items and the like in a simple and easy way which is effective as the conventional irons. It can readily be seen that it would be a substantial improvement in the art to provide a method and a machine to dewrinkles clothes items and the like placed in a container simply by high-pressure, high-humidity, and high-temperature air without the help of any other tool like means. Moreover, it would be a great improvement in the prior art to

provide an ironing machine which is very easy to use and is removing the wrinkles very effectively.

Disclosure of Invention

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method and an automatic ironing machine by which textile articles and the like are dewrinkled in a very easy and practical way with the help of high-pressure, high-humidity, and high-temperature air without using any means that touches the articles to be ironed by any part of the apparatus or tool like means that provides an additional tension on the textile articles and the like during ironing process and any other means such as clamps or cords or inflatable bags and the like for stretching the clothes or the sleeves.

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It is another object of the present invention to provide a method and an automatic ironing machine by which the textile articles and the like are dewrinkled either in a wet mode of operation or dry mode of operation.

It is still another object of the present invention to provide a method and an automatic ironing machine by which dewrinkled textile articles and the like are also dehumidified and/or cooled with the help of a refrigerating cycle and/or in the same way as in the conventional dryer.

These and further objects of the invention are achieved by a method of automatic ironing which is comprised of 5 stages wherein wet-ironing stage is the one in which textile articles and the like are dewrinkled simply by high-pressure, high-humidity, and high-temperature air, dehumidifying-stage is the one in which textile articles and the like are dehumidified by means of a refrigeration system, dry-ironing stage is the one in which textile articles and the like are dewrinkled by high-pressure, and high-temperature air, cooling-stage is the one in which textile articles and the like are cooled by means of a refrigeration system, finishing-stage is the one in which the ironing operation is completed.

These and further objects of the invention are achieved by an automatic ironing apparatus which is comprised of a box like unit, a container inside this box like unit which is resistant to high-pressure, high-humidity, and high-temperature air, a rack and
5 hangers inside the container to support clothes items and the like, an air compressor, a refrigerating system with an evaporator, a condenser, an expansion valve, and a compressor as in conventional systems, a steam generating system, a water supply system, air injection-exhaustion system, a control panel, an electronic control unit which controls all the stages of ironing operation as in conventional washing machines and dish
10 washers.

These and further objects of the invention are achieved by the operation of the automatic ironing apparatus as briefly described below in accordance with the method as stated above.

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After the textiles articles and the like are placed in the container, the doors are closed before on/off button is depressed. If the doors are not closed properly an alarm is activated. When the doors are closed properly, wet ironing stage is started by supplying water into the system. The water is used to produce steam in the steam generating tank
20 and the steam is guided into the container in order to humidify textiles articles and the like. Air compressor is actuated to compress air into the compressed air tank and the compressed air is guided into the container to increase the air pressure in the container. This operation is repeated until a pre-selected pressure level is provided in the container. When pre-selected pressure level is reached, the heater in the container is actuated in
25 order to increase the temperature in the container. When the pre-selected levels of pressure, temperature and humidity are reached, operation of the system is stopped and a rest period is provided. After the conclusion of the rest period high-pressure, high-humidity, and high-temperature air is discharged from the container.

30 In the dehumidifying stage the air in the container is circulated in the system by the operation of the air compressor. The refrigeration system is actuated and high-humidity, and high-temperature air is guided to the evaporator so that high-humidity, and high-temperature air is condensed into low-humidity, low temperature air. This air is drawn

by the air compressor to be delivered to the condenser so that, the low temperature air is heated before it is delivered back to the container. This cycle is repeated until a pre-determined condensation level is measured. Water condensed during the dehumidifying stage is delivered to a water tank and if the quantity of water is greater than a pre-determined amount, the pump is actuated to discharge the excess water from the system.

In the dry ironing stage air compressor is actuated to compress air into the compressed air tank and the compressed air is guided into the container to increase the air pressure in the container. This operation is repeated until a pre-selected pressure level is provided in the container. When pre-selected pressure level is reached, the heater in the container is actuated in order to increase the temperature in the container. When pre-selected levels of pressure, and temperature are reached, operation of the system is stopped and a rest period is provided. After the conclusion of the rest period high-pressure, and high-temperature air is discharged from the container.

In the cooling stage the air in the container is circulated in the system by the operation of the air compressor and refrigeration system is actuated. The high-temperature air is guided to the evaporator so that high-temperature air is condensed into low temperature air. This air is drawn by the air compressor to be delivered back to the container, and this cycle is repeated until a pre-determined temperature level is provided in the container. The high-temperature air around the condenser, a by-product of refrigeration cycle, is discharged out of the system by operation of a fan driven by a motor as utilized in conventional air conditioners.

During the ironing process as summarized above a multitude of valves are activated and stopped by the electronic control unit so that proper functioning of the apparatus is achieved in pre-determined and/or pre-selected order. In the last stage, the door of the box like unit is not unlocked; unless the measured temperature and pressure in the container are equal to or lower than a pre-determined level. When this condition is provided the door is unlocked. Thus, automatic ironing operation is completed.

Brief Description Of The Drawings

An illustrative embodiment of the invention is represented in the drawings and described in more detail in the following description. The present invention will be more apparent from the accompanying drawings, which is provided by way of non-limiting example and in which:

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FIG. 1 is a 3-dimensional exterior view of the automatic ironing machine in which automatic ironing process will take place showing the box like structure, control panel, and the door,

10 FIG. 2 is a 3-dimensional view of that same automatic ironing machine with its doors in an open position showing the inner chamber of the container with the rack and the hangers inside.

FIG. 3 is a schematic description of the parts of the automatic ironing machine,

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FIG. 4 is a schematic side elevational view, partly in section, of the automatic ironing machine with one set of parallel spaced conduits,

20 FIG. 5 is a schematic side elevational view, partly in section, of the automatic ironing machine with two sets of parallel spaced conduits,

FIG. 6 is a schematic rear elevational view, partly in section, of the automatic ironing machine,

25 FIG. 7 is a schematic side elevational view, partly in section, of the split type automatic ironing machine,

FIG. 8, FIG. 9, FIG. 10, FIG. 11, FIG. 12, FIG. 13 and FIG. 14 are the parts of a chart illustrating one of the alternative operations of automatic ironing machine according to the method of invention, in which Fig. 8 and Fig. 9 join at line "a", Fig. 9 and Fig. 10 join at line "b", Fig. 10 and Fig. 11 join at line "c", Fig. 11 and Fig. 12 join at line "d", Fig. 12 and Fig. 13 join at line "e", and Fig. 13 and Fig. 14 join at line "f" to form a

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chart illustrating the ironing process as one of the alternative embodiments of the invention.

5 In these figures, parts corresponding to those of the previously illustrated figures are indicated by the same reference numerals as they are used in the claims and description of the invention.

Modes For Carrying Out The Invention

10 The main object of the present invention is to provide a method and an apparatus for automatic ironing of the textile articles and the like in a very simple and practical way for the users in which dewrinkling is done simply by high-pressure, high-humidity, and high-temperature air without touching the articles to be ironed by any part of the apparatus or tool like means to provide an additional tension on the textile articles and
15 the like during ironing process and without using any other means such as clamps or cords or inflatable bags and the like for stretching the clothes or the sleeves.

It is another object of the present invention to provide a method and an automatic ironing machine by which the textile articles and the like are dewrinkled either in a wet
20 mode of operation or dry mode of operation.

It is another object of the present invention to provide a method and an automatic ironing machine by which dewrinkled textile articles and the like are also dehumidified and/or cooled with the help of a refrigerating cycle and/or in the same way as in the
25 conventional dryer.

It is still another object of the present invention to enable the dehydrating process to be controlled in an optimum manner independently of the wetness and the type of fabric of the clothes' items and the like.

30 These and further objects which will be apparent to the expert of the art are attained by a method of the stated type used in an automatic ironing machine or the like of afore said type will be described in more detailed as in the following.

Referring now to drawings, there is illustrated an exemplary embodiment of a method and an apparatus for automatic ironing of the textile articles and the like according to the present invention. The apparatus shown in Fig. 1 and Fig. 2 is comprised of a box like ironing unit (2) having opposite side surfaces at the left and right(3a and 3b), a top surface(4), a rear surface(5), and a front surface(6) locations of which are defined with respect to the user, a door (7) on said front surface(6) or said side surfaces at the left and right(3a and 3b) locking an unlocking of which is operated by the electronic control unit(1) as in conventional washing machines, a base part (8) at the bottom of the front surface(6) and a control-panel(9) on the upper part of the front surface(6) and a container(10) for receiving textile articles and the like into its inner chamber.

The container(10) which is resistant to high-temperature, high-humidity, and high-pressure, has opposite side surfaces at the left and right(26a and 26b), a top surface(27), a rear surface(28), a bottom surface(29) and a front surface(30) locations of which are defined with respect to the user, as shown in Fig. 2. A door(31) is provided on said front surface(30) or said side surfaces at the left and right(26a and 26b) of said container(10) which is resistant to high-temperature, high-humidity, and high-pressure, and assuring a perfect closure tightness. A rack(32), is fixed to said side surfaces(26a and 26b) of said container(10), to which plurality of hangers(33) are attached for supporting clothes item and the like within the inner chamber of said container(10) as shown in Fig. 2. There is an intake port preferably at the back of the bottom surface and an discharge port preferably at the center of the top surface(27) of the container(10) to which air distribution conduit (36a) and air discharge conduit(23) is mounted, respectively as shown in Fig. 4.

An air injection system(12) is provided which expels approximately evenly distributed streams of air into said container(10) to increase air pressure inside its inner chamber, comprising an air compressor(19), a compressed air storage tank(20) coupled to said air compressor(19), air distribution conduits (36a and 36b), a plurality of parallelly spaced conduits(37a, 37b, 37c, 37d, and 37e), and an air supply conduit(22) and an air discharge conduit(23) as shown in Fig. 4 and Fig. 5. First air distribution conduit(36a) is coupled to said air compressor(19) and second distribution conduit(36b) is perpendicularly

coupled to said first distribution conduit(36a) and thereto said plurality of parallelly spaced conduits(37a, 367, 37c, 37d, and 37e) are perpendicularly coupled. Parallelly spaced conduits(37a, 37b, 37c, 37d, and 37e), are perpendicular to the rear surface(28) of the container(10) and parallel to the bottom surface(29) of the container(10), each of which approximately has a length extending from front surface(30) to rear surface(28) of said container(10), as shown in Fig. 4. Parallelly spaced conduits(37a, 37b, 37c, 37d, and 37e) are comprised of a pipe on which there are plurality of spaced air vents(38a, 38b, 38c, 38d, 38e, etc) the sizes of which increase towards the end of the respective conduit which is further away from the second distribution conduit(36b) so that air expels upwards, and sideways therefrom with approximately equivalent pressure towards the clothes items and the like, as shown in Fig. 4.

Air compressor(19) comprises power cable(not shown) for powering air compressor(19) and is equipped with a switch(not shown) which allows the compressor to stop when pre-selected pressure level has been reached in compressed air storage tank(20) as shown in Fig. 4. and Fig. 5. Air compressor(19) is coupled to compressed air storage tank(20) by inlet and outlet conduits(not shown), the first of which is for inflow of air and the second of which is for discharge of compressed air, the conduits being equipped with valves(53g and 53h) respectively as shown in Fig. 3. Air compressor(19) functions to compress air into the compressed air storage tank(20), and to circulate the air in the system between the container(10), the air cooling tank(48) and/or air heating tank(50). Air compressor(19) is coupled to a first distribution conduit(36a) which is vertically coupled in the center of the rear surface(28) of said container(10).

An alternative embodiment of the invention may be a split type to provide quietness and less space inside the building or to increase security which functions in a way similar to the split air conditioning devices found in the market. In this split type of the invention the air compressor(19) which is located below the container(10) in the integral type, is placed in a second box like unit(64) with the compressed air storage tank(20), the second box like unit(64) being placed outside the wall behind the box like unit(2), as shown in Fig. 6.

The heater(45a) serving as the heat source for increasing the temperature of the air in the container(10) is mounted on said bottom surface(29) to which suitable wiring is provided. The capability of the heater(45a) is set about 1200 W approximately which is of a general level for home appliances, and may be over this value for industrial
5 appliances. The operation of the heater(45a and 45b) is conventional and will not be described more fully herein. Typically a thermostat is used to regulate the level of temperature in the container required in the dewrinkling stages (Stage A and Stage C) of the ironing cycle. Once a pre-selected temperature is reached, the ironing operation continues for a fixed time during the rest period as set by the user.

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The compressed air flow is preferably taken from the rear side of the container(10) and is discharged from the center of top surface(27) of the container(10) through the air discharge conduit(23) as shown in Fig. 4 and Fig. 5. Air compressor(19) produces a flow of compressed air to the compressed air storage tank(20) and therefrom to air
15 distribution conduits(36a and 36b) and to parallelly spaced conduits(37a, 37b, 37c, 37d, and 37e). Streams of air expel upwards and sideways from plurality of air vents(38a, 38b, 38c, 38d, 38e, etc) on the parallelly spaced conduits(37a, 37b, 37c, 37d, and 37e). As shown in Fig. 4, each air vent is an aperture formed in its respective conduit for expelling therefrom streams of air. Since the size of each air vent increases towards the
20 end of the conduit which is further away from said second distribution conduit(36b) as stated above, the distribution and evenness of the forced air to the clothes items and the like in the container(10) is significantly increased.

An alternative for the air injection-exhaustion system may be introduced, comprising
25 two sets of parallelly spaced conduits, one of which (37a, 37b, 37c, 37d, 37e, and 37f) is parallel to the bottom surface(29) of said container(10), the second of which (37f, 37g, 37h, 37i, 37j, 37k) is parallel to the top surface(27) of the container(10), above the hangers(33), and which are perpendicularly coupled to said second distribution conduit(36b) vertically coupled at the back of the bottom surface(29) so that a thin layer
30 of moisture is more evenly distributed on the clothes items and the like in the container(10) as shown in Fig. 6. The thin layer of moisture aids in smoothing and dewrinkling the clothing and since moisture layer is evenly distributed, there is no problem with spotting of the clothing. Furthermore, the thin layer of moisture is not

sufficient to saturate the clothing which can have a negative impact on dewrinkling performance by increasing the time required for dehumidifying.

A temperature detecting means(15a), a pressure detecting means(16a), a humidity
5 detecting means(17) for sensing the temperature, pressure and humidity of the air inside
said container(10) respectively, is mounted on the air discharge conduit(34) so that pre-
selected time for the dewrinkling stages(Stage A and Stage C) can be modified by the
electronic control unit(1) depending on the measured levels of temperature, pressure,
and humidity of the air in the container(10). A lint filter(39) for removing lint from the
10 air circulating in the system is detachably provided in front of the air discharge
conduit(34) which is vertically coupled in the center of the top surface(27) of the
container(10). Thus, the lint and dust is removed from the air discharged from the
container(10). Then, since the air compressor(19) will not be entangled or clogged with
the lint or the large dust, a decrease in the performance of the air compressor(19) can be
15 prevented.. When the lint filter is periodically removed and cleaned, the efficiency of the
air compressor(19) can be maintained. Air discharge conduit(34) vertically coupled in
the center of the top surface(27) of the container(10) and air discharge conduit(23a) is
equipped with valves(53j and 53k) respectively to control the discharge of high-
temperature, high-humidity, high-pressure air in the container(10) as shown in Fig.3.

20 The steam generating tank(40) for producing steam to humidify the textiles articles and
the like in said container(10) is located below the container(10) configured and mounted
so as to occupy very low height in the base part(8) of the box like ironing unit(2) as
shown in Fig.4 and Fig. 5. The steam generating tank(40) is coupled to the air
25 compressor(19) by 2 conduits(not shown) and as shown in Fig. 3, 2 valves(53b and 53c)
are provided for opening and closing of the conduits in response to the electronic control
unit(1) to provide steam during the wet ironing stage .The water tank(41)is coupled to
the steam generating tank(40). A pump(43) is coupled to the water tank(41) in the
bottom for pumping water from the water tank(41) to the steam generating tank(40) and
30 for draining the excess water from the water discharge conduit(25) including 2
valves(53o and 53p) for controlling water flow in response to the electronic control
unit(1) as shown in Fig. 3. According to the present embodiment, the water tank(41) is
advantageously removable through a lid(42) to put in demineralized water and to allow

the demineralized water contained in to be used for known purposes, whereas according to another alternative embodiment of the invention, a supply conduit(24) is coupled to the steam generating tank(40) for water supply from the mains. The steam generating tank(40) may be similar to the steam generating means disclosed in U.S. Pat. No:
5 4,810,854 to Jurish et. al., herein incorporated by reference.

An idea of utilizing a refrigerating cycle of an air conditioner to the ironing machine as described in exemplary embodiment of the present invention has been proposed for dehumidifying and/or cooling the textile articles and the like. Concerning this, a
10 refrigerating system(21) is provided which is comprised of evaporator(46) condenser(48), an expansion valve(50), and a compressor(51), all of which are connected to each other with pipes and the like. The refrigerating cycle is provided in order to dehumidify, cool, and/or heat the air in said container(10). In this refrigerating cycle, the refrigerant compressed by the compressor(51) is condensed into liquid in the
15 condenser(48) which may be of the usual tube and fin type. This liquid is then made into low-pressure, low temperature liquid by the expansion valve(50) and is supplied to the evaporator(46) which may be of the usual tube and fin type. The refrigerant is then returned to the compressor(51).

20 The evaporator(46) and the condenser(48) are mounted in an air cooling tank(47), an air heating tank(49), respectively so that they can be utilized to dehumidify, cool and/or heat the air in the system as shown in Fig. 3, Fig.4, and Fig.5. The container(10), the air compressor(19), the air cooling tank(47) and the air heating tank(49) are coupled to each other with conduits and the like so that the air can circulate in the system by the
25 operation of the air compressor(19) as shown in Fig.3. A water tank(41) is also provided to collect the condensing water during dehumidification process (Stage B) in the air cooling tank(47) when the high-humidity air is in direct contact with the evaporator(46). The water tank(41) is coupled to both the air cooling tank(47) and the steam generating tank(40) with pipes and the like as shown in Fig. 3. The air cooling tank(47) is coupled
30 to said water tank(41) by a drain pipe for discharging water content generated during the dehumidifying process from the lower part of air cooling tank(47). Furthermore, regarding the cooling tubes or fins, they have a slant on the drain side to quickly remove the generated water content, thereby improving the efficiency of the refrigerating cycle

and the bottom surface of the air cooling tank(47) has a slant towards the drain side to quickly discharge the water content. A ventilation box(52) is mounted to air heating tank(49) to circulate cool air through said air heating tank(49) by means of a fan and a fan motor (not shown) as used in conventional air conditioners in order to cool the
5 condenser(48) during cooling stage (Stage D).

By the operation of the members described above, the clothes items and the like in the container(10) is quickly dried and cooled with highly dehumidified air in accordance with the operation of the refrigerating cycle. The air in the system may also be heated by
10 the condenser(48) during the operation of the refrigerating system(21) Alternatively, when the refrigerating cycle is not utilized, the high-temperature, high-humidity air may be air cooled by natural air, dehumidified by heat exchange as in conventional systems, and returned to the container(10) by circulation. Thus, the clothes items and the like are dehumidified by the heat exchange method in the same manner as in the conventional
15 dryer and is dried with hot air heated by the heater(45a). This conventional method is not further described in this embodiment of the invention.

A condensation detecting means(18) to measure the quantity of condensed water released from the clothes items and the like during dehumidification stage is comprised
20 of an impeller(not shown) fixed on a rotating shaft mounted in the discharge pipe connecting the air cooling tank(47) and water tank(41), a comparator or similar member or circuit(not shown) coupled to the impeller, a tachometer dynamo to measure the rotational speed of the shaft on which the impeller is mounted. .

25 A water supply conduit(24) interposed with a water supply valve(53a) is connected to the upper portion of the steam generating tank(40), and is connected to the water tap. A water supply sensor(not shown), e.g., a differential pressure, electro magnetic, volume, or ultrasonic type flow rate sensor is mounted to the water supply conduit(24) as in conventional washing machines. A water amount detecting means(44), e.g., a water level
30 sensor, a weight sensor is mounted to the water tank for measuring the quantity of stored water released by the clothes items and the like in the container(10) and for controlling the length of dehumidifying cycle (Stage B). The water quantity in said water tank(41) is measured on the basis of water weight or the basis of the determination of electrical

- members operationally connected to the water present in the water tank(41), or on the basis of variation in the current absorbed by the pump(43) which is determined digitally or analogically or by measuring the variation in said quantity functionally associated with said current as disclosed in U. S. Pat. No: 5,228,212 herein incorporated by
5 reference. The pump(43) which is coupled to the water tank(41) functions also to discharge the water released by the clothes items and the like in the container(10) during dehumidification stage, if the water in the water tank(41) exceeds a pre-determined amount.
- 10 It should be noted that the method of invention is capable of implementation with a variety of compressors, motors and pumps. Therefore, the compressors(19 and 51), the fan motor(not shown) and the pump(43) shown in the drawings and mentioned above is merely intended to illustrate an exemplary of the present invention as currently
15 contemplated by the inventor and is in no way meant to limit the use and scope of the claimed method and apparatus. In the preferred embodiment, the plurality of conduits and tanks are made of metal, plastic or any other suitable material for containing and/or passing therethrough high-temperature, and/or high-humidity, and/or high-pressure air. During the operation of the ironing process plurality of
20 valves(53a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,r,s,t and 50) which are mounted to the related conduits are activated and stopped by the electronic control unit(1) as shown in Fig.3.

- In the automatic ironing machine as described above, the operation of the ironing process is controlled by an electronic control unit(1) comprising a microprocessor or a microcomputer in accordance with the ironing steps. Respective steps of the ironing
25 operation are executed by the electronic control unit(1) based on input signals from the control panel(9) and output signals from the temperature detecting means(15a and 15b), pressure detecting means(16a and 16b), humidity detecting means(17), water amount detecting means(44), water supply sensor(not shown), the door sensors(not shown) coupled to the doors(7 and 31) of the box like unit(2) and the container(10) as utilized in
30 conventional washing machines, and the like.

Although not shown, the electronic control unit(1) has drive circuits for driving the respective valves, drive circuits for driving the compressors(19 and 51), fan motor(not

shown), the pump(43) and the like. A number of possible embodiments exist for the electronic control unit(1) and the invention is not limited to any particular embodiment. For example, electronic control unit(1) may comprise a closed loop feedback system including a microprocessor, a micro controller, an application specific integrated circuit(ASIC), a digital signal processor(DSP) or other processor. The microprocessor or other processor may incorporate a linear or non-linear closed loop feedback control algorithm. The electronic circuitry may incorporate analog electronic circuit components, digital electronic circuit components or both. It will be appreciated by those skilled in the art that a multitude of possible electronic circuits may be designed and constructed to implement a multitude of possible alternative control systems.

The electronic control unit(1) is coupled to a control-panel(9) which is comprised of an on/off button(58), wet/dry button(59) for dewrinkling in wet mode which is signified by bluish color or the like and which starts the ironing cycle from phase A and after completion of this phase starts phase B, phase C, phase D, and phase E one after another when in use or for dewrinkling in dry mode which is signified by yellowish color or the like and which starts phase C, phase D, and phase E one after another when in use, a humidity level button(60) with 4 different humidity levels selectable by the user ranging from no-humidity to minimum-humidity, medium-humidity, and maximum-humidity, a temperature level button(61) for setting the desired temperature level which is suitable for the fabrics of the items inside said container(10), a pressure level button(62) with 3 different pressure levels selectable by the user suitable for the clothes items and the like ranging from low pressure, to medium pressure, and high pressure, a timer (63a) being capable of setting the duration of wet mode of the ironing process in short, medium, and long periods which is signified by bluish color or the like, and a second timer (63b) being capable of setting the duration of dry mode of the ironing process in short, medium, and long periods which is signified by yellowish color or the like. The electronic control unit(1) and the control-panel(9) are mounted on the upper part of said front surface of said (6) box like structure(2) as shown in Fig. 1.

The present embodiment of the invention as described below humidifies, applies pressure, heats, and/or cools, and/or dehumidifies textile articles and the like by the operation of an ironing cycle for dewrinkling of these articles effectively. Accordingly,

an arrangement for obtaining pressure, heating, and/or cooling, and/or dehumidifying functions of the present invention as one of possible embodiments will be described below as shown in Fig 8, Fig.9, Fig. 10, Fig. 11, Fig. 12, Fig. 13 and Fig 14 which are illustrating together a single chart describing one of the alternative operations of automatic ironing machine according to the method of invention. Fig 8, Fig.9, Fig. 10, Fig. 11, Fig. 12, Fig. 13 and Fig 14 operate with electronic control unit(1) which is a microprocessor or controller sending control signals to the transistor drivers(not shown), which then sends signals to the compressor relay(not shown)., pump relay(not shown)., the heater relay(not shown). and the related valves. When the compressor relay receives a signal from the transistor drivers the relay activates the compressor. Similarly when the pump relay receives a signal from the transistor drivers the relay activates the pump and when the heater relay receives a signal from the transistor drivers, the heater is controlled via a high limit thermostat(not shown).

An ironing operation of the method and apparatus for automatic ironing discussed above is described hereinafter, comprising Stage A which is dewrinkling stage simply by high-temperature, high-humidity, and high-pressure air, Stage B which is dehumidifying, stage, Stage C which is dewrinkling stage simply by high-temperature, and high-pressure air, and Stage D which is cooling stage, and Stage E which is conclusion of the ironing cycle. First clothes items and the like are mounted on the hangers(33) in the container(10) and the door(7) of the box like unit(2) is shut after the door(31) of the container(10). For the ironing operation it is assumed that the clothes items and the like are already cleaned and they may be dry or still wet before they are subject to ironing operation..

On/off button(58) depressed to start the operation after all the buttons on the control panel(10) are also set in accordance with the requirements of the user. If the clothes items and like will be dewrinkled in dry mode, then dry/wet button(59) is set to dry mode which is yellowish for starting the ironing process from Stage C. If the clothes items and the like are already wet the humidity level button(60) is set to no-humidity level and the dry/wet button(59) is set to wet which is bluish. In order to describe ironing cycle in full, the clothes items and the like are assumed to be dry herein. A plurality of buttons are set according to the needs of the user by means of the timers(62a and 62b),

temperature level button(61), humidity level button(60) to set the length of the dry or wet stages, the temperature suitable to the fabrics of the clothes items and the like, and the amount of steam suitable to humidify the clothes items and the like, respectively.

- 5 When the on/off button(58) is depressed, a signal is provided by the door sensors to the electronic control unit(1). If one of the doors or both doors are not closed properly an alarm is activated by the electronic control unit(1) Stage A starts if both doors(7 and 31) are properly closed and the electronic control unit(1) operates to activate the water supply valve(53a) so that water is added to the steam generating tank(40) during a pre-determined time. Then, the water supply valve(53a) is closed and the quantity of water
10 in the steam generating tank(40) is measured by water amount detecting means(18b). If the quantity of water in the steam generating tank(40) is less than a pre-selected amount, the water supply valve(53a) is activated. When the quantity of water in the steam generating tank(40) measured by water amount detecting means(18b) is equal to or
15 greater than a pre-selected amount, the water supply valve(53a) is closed.

- Then water in the steam generating tank(40) is heated to produce steam in order to humidify the clothes items and the like in the container(10)during a pre-determined time. As shown in Fig. 3, the valves(53b and 53c)on the inlet and outlet conduits mounted to
20 the steam generating tank(40), the valve(53i) on the inlet conduit mounted to the air distribution conduit(36a), and the valve(53j) mounted to the discharge conduit(34) are activated while valves (53d, 53e, 53f, 53g, 53h, 53k, 53l, 53m and 53n) are still closed and the air compressor(19) is actuated so that steam is delivered to the container(10) and circulated in the system. The above operation is repeated until the humidity level inside
25 the container reaches a pre-selected level set by the humidity level button(60). When the amount of humidity measured by the humidity detecting means(17) is equal to or greater than the pre-selected humidity level, the valves(53b, 53c) on the inlet and outlet conduits mounted to the steam generating tank(40), are closed, and the operation of the steam generating system(14) is stopped. An advantage of this method of operation is that
30 during the steam period a layer of moisture is generally evenly distributed on the clothes item and the like. High-humidity air is circulated in the system by the operation of the air compressor to ensure uniform distribution of moisture on the clothes item and the like.

When the pre-determined humidity level inside the container is provided, the valves(53j) on the air discharge conduit(34) mounted to the container(10) and the valve(53i) on the inlet conduit mounted to the air distribution conduit(36a) and the valve(53h) on the outlet conduit connected to the compressed air tank(20) is closed, the valve(53g) on the inlet conduit connected to the compressed air tank(20) and the valve(53n) mounted to the air supply conduit(22) are activated and the air compressor(19) is actuated by the electronic control unit(1). The air is compressed into the compressed air tank(20) by the air compressor and the pressure in the compressed air tank(20) is measured by pressure detecting means(16b) successively or continuously.

The air compressor(19) continues to compress air into the compressed air tank(20) until a pre-selected pressure level is reached inside it. When the amount of air pressure measured by pressure detecting means(16b) connected to the compressed air tank(20) is equal to or more than the pre-selected pressure level, a signal is provided to the electronic control unit(1) by the pressure detecting means(16b), and the air compressor(19) is stopped. Then the valve (53g) mounted to the inlet conduit connected to the compressed air tank(20) the valve(53n) mounted to the air supply conduit(22) are closed and the valve(53i) mounted to the air supply conduit(22) connected to the container(10), the valve(53h) on the outlet conduit mounted to the compressed air tank(20) are opened so that high-pressure air is guided to the air distribution conduits(36a and 36b), therefrom to the parallelly spaced conduits (37a, 37b, 37c, 37d, 37e, and 37f). As can be predicted the plurality of parallelly spaced conduits(37a, 37b, 37c, 37d, 37e, and 37f) each of which has formed therein a plurality of air vents(38a, 38b, 38c, 38d, 38e, etc.) increases significantly the distribution and evenness of the forced air to the clothes items and the like in the container(10).

The injection pressure of the air from the air vents is determined by the pressure in the compressed air tank(20). The pressure of the air in the compressed air tank(20) is set in accordance with the material of the clothes items and the like by the pressure level button(62). For example, if the material is cotton the pressure is set to a high level and low if the material is silk. Thus, the clothes items and the like can be dewrinkled and smoothed in a suitable gentleness without being damaged during the ironing process.

The amount of pressure in the container(10) is measured by the pressure detecting means(16a) and a signal is provided to the electronic control unit(1). If the air pressure inside the container is lower than a pre-selected level, then air compressor is actuated
5 again and the cycle described above is repeated until the pre-selected pressure level is provided in the container(10). When the pressure level in the container(10) is equal to or greater than the pre-selected pressure level, air compressor(19) is stopped and the valve(53i) on the inlet conduit mounted to the container(10) and the valve(53n) mounted to the air supply conduit(22) are closed as well as the valves(53g and 53h) on the
10 conduits mounted to the compressed air tank(20).

When the pressure level in the container is equal to or greater than the pre-selected pressure level the heater(45a) in the container(10) is activated by the electronic control unit(1) intermittently and/or continuously in order to heat the clothes items and the like
15 inside the container(10). The heating cycle continues until the temperature of the air in the container(10) measured by the temperature detecting means(15a) is equal to or greater than the pre-selected temperature. When the levels of temperature, pressure, and humidity measured by temperature detecting means(15a) pressure detecting means(16a), and , the humidity detecting means(17), respectively are equal to or greater than the pre-
20 selected levels the operation is stopped for a pre-determined period of time in order to provide a rest period.

Thus, enough time is provided for the clothes items and the like to remain in high-temperature, high-humidity, and high-pressure air in order to achieve proper
25 dewrinkling. After the rest time is completed, the valve(53j) on the air discharge conduit(34) mounted to the center of top surface(27) of the container(10) and the valve(53k) on the air discharge conduit(23a) are opened and, thus, high-temperature, high-humidity, and high-pressure air discharges from the discharge port leaving all the lint on the lint filter. In this manner high-temperature, high-humidity, and high-pressure
30 air is discharged from the container(10) and may be connected with duct work such that the exhaust air is vented out of the user's place as in conventional methods or may be used for heating and humidifying the air as in United States Patent 5,768,730 herein incorporated by reference.

The pressure of the air in the container(10) is measured by the pressure detecting means(16a) after a predetermined time. When the air pressure in the container(10) is below a pre-determined amount, the valve(53k) mounted to the air discharge conduit(23a) is closed and Phase B starts for dehumidification of the clothes items and the like. While the valve(53j) mounted to the air discharge conduit(34) mounted to the center of top surface(27) of the container(10) is still open, the valves(53l and 53m) mounted to the inlet and outlet conduits of the air cooling tank(47), the valves(53d and 53e) mounted to the inlet and outlet conduits of the air heating tank(49), and the valve(53i) on the inlet conduit mounted to the container(10) are opened, while all the other valves(53b, 53c, 53f, 53g, 53h, 53n) are still closed. The air compressor(19) is actuated in order to circulate the high-humidity, high-temperature air between the container(10), the air cooling tank(47), and the air heating tank(49).

The high-humidity, high-temperature air in the container(10) is guided to the air discharge conduit(34) and then to air cooling tank(47) by the operation of the air compressor(19). The refrigerating cycle starts operating to circulate the refrigerant through the evaporator(46) and the condenser(48) by actuating the compressor(51). The high-humidity, high-temperature air in the air cooling tank(47) is condensed into low temperature, low-humidity air by the evaporator(46) in the air cooling tank(47), and is drawn by the air compressor(19) to be delivered to the air heating tank(49). Low temperature, low-humidity air is heated in the air heating tank(49) by the condenser(48), and the high-temperature, low-humidity air is delivered back to the container(10) through the respective conduits.

Water released by the clothes items and the like during condensation of the high-temperature, high-humidity air is discharged through a discharge pipe mounted to the bottom of the air cooling tank(47). The level of condensation is measured by measuring the flow rate of condensed water released by the clothes items and the like during the dehumidifying cycle (Stage B). The flow rate of the water released by the clothes items and the like through the pipe connecting the air cooling tank(47) and the water tank(41) is a direct indication of dehydration level and is utilized for controlling the length of the dehumidifying cycle. A signal is provided for stopping the dehumidifying cycle if the

measurement is equal to or lower than a predetermined value. The signals are fed to the electronic control unit(1) which controls the dehumidifying cycle, the electronic control unit(1) monitoring the measured flow rate of condensed water, and acting to terminate the dehumidifying cycle when the flow rate has reached a pre-determined level.

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During the initial stage of dehydration a large amount of water is present in the clothes items and the like, and consequently more water is condensed causing a high rate of water flow in the discharge pipe. The water strikes the impeller fixed on an idle shaft at least partly emerging from said pipe and rotating even with a small amount of water flow. The rotational speed of the shaft is measured by a tachometer dynamo that generates electrical signals based on this measurement. The signals are compared in the comparator with reference or threshold signals. As a result of this comparison the comparator generates signals which are fed to the electronic control unit(1). As dehydration process continues the water quantity in the clothes items and the like begins to fall, and consequently the water flow rate through the pipe also falls. When the water flow rate measured by the rotation of the impeller is equal to or lower than a predetermined level, the dehydrating of the clothes item and the like is considered complete by virtue of the fact that no more water is discharged from them or that the water discharge corresponds only to the usual moisture naturally present in the clothes. Then the dehydrating stage is stopped.

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Alternatively, the amount of condensation of water released from the clothes items and the like during dehydration stage may also be measured directly or indirectly by the variation of the current absorbed by the pump during the evacuation of the water from the water tank(41) or by variation in the characteristics of a resistor inserted into the water tank(41) as disclosed in U. S. Pat. No: 5,228,212 herein incorporated by reference. When the variation has a negative gradient or when the signals correspond to a constant value dehydrating stage is stopped.

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The power feed to the air compressor(19) providing air circulation through the container(10), air cooling tank(47), air heating tank(49), and the relevant conduits connecting them, is cut on the basis of the measured data concerning the level of condensation directly related to the water quantity released by the clothes. The

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valves(53i, 53j, 53l, 53m, 53d, 53e) are closed at the end of dehumidifying stage as well. During the dehumidifying cycle (Stage B) the quantity of the water deposited in the water tank(41) is measured by the water amount detecting means(44) and if the measured quantity is greater than a pre-determined amount then for the first time, the valves(53o and 53p) mounted to the water tank(41) are activated to drain the excess amount of water into the steam generating tank(40) and for the second time out of the system through the water discharge conduit(25). Then the pump(43) is stopped and the valves(53o and 53p) mounted to the water tank(41) are closed. When the measurement of the quantity of the water in the water tank(41) during dehumidifying stage by the water amount detecting means(44) is greater than a pre-determined amount for the second time, then the valve(53o) is closed and the pump(43) is actuated to discharge the excess water. Then pump(43) is stopped and the valve(53o) is closed.

After the conclusion of dehumidifying stage (Stage B), the dry stage (Stage C) starts to dewrinkle the clothes items and the like in the container(10). The valves(53j) on the air discharge conduit(34) mounted to the container(10) and the valve(53i) on the inlet conduit mounted to the air distribution conduit(36a) and the valve(53h) on the outlet conduit connected to the compressed air tank(20) is closed, the valve(53g) on the inlet conduit connected to the compressed air tank(20) and the valve(53n) mounted to the air supply conduit(22) are activated and the air compressor(19) is actuated by the electronic control unit(1). The air is compressed into the compressed air tank(20) by the air compressor and the pressure in the compressed air tank(20) is measured by pressure detecting means(16b) successively or continuously.

The air compressor(19) continues to compress air into the compressed air tank(20) until a pre-selected pressure level is reached inside it as described above in relation to Stage A. When the amount of air pressure measured by pressure detecting means(16b) connected to the compressed air tank(20) is equal to or more than the pre-selected pressure level, a signal is provided to the electronic control unit(1) by the pressure detecting means(16b), and the air compressor(19) is stopped. Then the valve (53g) mounted to the inlet conduit connected to the compressed air tank(20) the valve(53n) mounted to the air supply conduit(22) are closed and the valve(53i) mounted to the air supply conduit(22) connected to the container(10), the valve(53h) on the outlet conduit

mounted to the compressed air tank(20) are opened so that high-pressure air is guided to the air distribution conduits(36a and 36b), therefrom to the parallelly spaced conduits (37a, 37b, 37c, 37d, 37e, and 37f). As can be predicted the plurality of parallelly spaced conduits(37a, 37b, 37c, 37d, 37e, and 37f) each of which has formed therein a plurality of air vents(38a, 38b, 38c, 38d, 38e, etc.) increases significantly the distribution and evenness of the forced air to the clothes items and the like in the container(10).

The injection pressure of the air from the air vents is determined by the pressure in the compressed air tank(20). The pressure of the air in the compressed air tank(20) is set in accordance with the material of the clothes items and the like by the pressure level button(62). For example, if the material is cotton the pressure is set to a high level and low if the material is silk. Thus, the clothes items and the like can be dewrinkled and smoothed in a suitable gentleness without being damaged during the ironing process.

The amount of pressure in the container(10) is measured by the pressure detecting means(16a) and a signal is provided to the electronic control unit(1). If the air pressure inside the container is lower than a pre-selected level, then air compressor is actuated again and the cycle described above is repeated until the pre-selected pressure level is provided in the container(10). When the pressure level in the container is equal to or greater than the pre-selected pressure level, air compressor(19) is stopped and the valve(53i) on the inlet conduit mounted to the container(10) and the valve(53n) mounted to the air supply conduit(22) are closed as well as the valves(53g and 53h) on the conduits mounted to the compressed air tank(20).

When the pressure level in the container is equal to or greater than the pre-selected pressure level the heater(45a) in the container(10) is activated by the electronic control unit(1) intermittently and/or continuously in order to heat the clothes items and the like inside the container(10). The heating cycle continues until the temperature of the air in the container(10) measured by the temperature detecting means(15a) is equal to or greater than the pre-selected temperature. When the levels of temperature, and pressure measured by temperature detecting means(15a), and pressure detecting means(16a) respectively are equal to or greater than the pre-selected levels the operation is stopped for a pre-determined period of time in order to provide a rest period.

Thus, enough time is provided for the clothes items and the like to remain in high-temperature, and high-pressure air in order to achieve proper dewrinkling. The relative amount of the pressure in Stage C is greater than the amount of pressure in Stage A so
5 that the finest wrinkles are removed and the clothes items are smoothed more effectively during this stage. After the rest time is completed, the valve(53j) on the air discharge conduit(34) mounted to the center of top surface(27) of the container(10) and the valve(53k) on the air discharge conduit(23a) are opened and, thus, high-temperature, high-humidity, and high-pressure air discharges from the discharge port leaving all the
10 lint on the lint filter. In this manner high-temperature, and high-pressure air is discharged from the discharge port leaving all the lint on the lint filter. In this manner high-temperature, high-humidity, and high-pressure air is discharged from the container(10) and may be connected with duct work such that the exhaust air is vented out of the user's place as in conventional methods or may be used for heating.

15 The pressure of the air in the container(10) is measured by the pressure detecting means(16a) after a predetermined time. When the air pressure in the container(10) is below a pre-determined amount, the valve(53k) mounted to the air discharge conduit(23a) is closed and Stage D starts for cooling the clothes items and the like.
20 While the valve(53j) mounted to the air discharge conduit(34) mounted to the center of top surface(27) of the container(10) is still open, the valves(53l and 53m) mounted to the inlet and outlet conduits of the air cooling tank(48), and the valve(53i) on the inlet conduit mounted to the container(11) are opened, while all the other valves(53b, 53c, 53d, 53e, 53f, 53g, 53h, 53n, 53r, 53s) are still closed and the air compressor(19) is
25 actuated in order to circulate the high-temperature air between the container(10), the air cooling tank(47).

The refrigerating system(21) starts to function as the air compressor(19) is actuated to circulate the air in the system in order to cool the high-temperature air delivered from
30 the container(10) to the air cooling tank(47) during Stage D. The high-temperature air in the air cooling tank(47) is condensed into low-temperature air by the evaporator(46), and is drawn by the air compressor(19) to be delivered to the container(10). Low temperature air becomes high-temperature air as a result of its contact with the high-temperature

clothes items and the like in the container(10) and is delivered back to the air cooling tank(47) so that high-temperature air will become low-temperature air. This cooling cycle continues until the amount of temperature in the container(10) measured by the temperature detecting means(15a) is equal to or lower than a pre-determined level.

- 5 When the amount of temperature in side the container(10) is equal to or lower than the pre-determined temperature level, the refrigerating cycle and the air circulation is stopped and the valves(53l, 53m, and 53i) are closed.

- 10 During the cooling stage the temperature in the air heating tank(49) increases as a result of refrigeration cycle. Air circulation in the air heating tank(49) is provided by means of a fan driven by a fan motor mounted to the ventilation box(52). The valves(53s and 53t) mounted to inlet conduit and outlet conduit mounted to the ventilation box(52), the valve(53r) mounted to the conduit connecting the air heating tank(49) and the air supply conduit(22) are activated in order to provide fresh air from the outside to cool the
15 condenser(48) in the air heating tank(49),. The fan motor(not shown) is actuated during the cooling stage (Stage D) by the electronic control unit(1) so that high-temperature air in the air heating tank(49) is discharged out to provide efficient functioning of the refrigerating cycle.

- 20 If the ironing cycle is started from Stage C for dry ironing of the clothes items and the like, it is assumed that already cleaned and dry articles of clothing will be mounted to the hangers in the container and will be exposed to high-temperature, high-pressure air as described above. In order start the program directly from Stage C wet/dry button is set to dry mode, all the related buttons on the control panel(9) are set in accordance with the
25 requirements of the user, and after the door(31) of the container(10) and door(7) of the box like unit(2) are closed the on/off button is depressed to start the ironing operation. If one of the doors or both doors are not closed properly an alarm is activated by the electronic control unit(1). Stage C starts if both doors(7 and 31) are properly closed. At the conclusion of Stage C in which the clothes items and the like are dewrinkled by
30 high-temperature, and high-pressure air, Phase D will start to cool the clothes items and the like in the container(10) as described above.

When the ironing cycle comprised of Stage A, Stage B, Stage C, and Stage D is completed in wet mode, and the ironing cycle comprised of Stage C, and Stage D is completed in dry mode, Stage E starts. The electronic control unit(1) receives input signals from the pressure detecting means(16a) and temperature detecting means(15a) showing the amount of the pressure and temperature of the air in the container(10). The electronic control unit(1) sends an output signal to the door sensors if the measured amount of the pressure and temperature of the air in the container(10) is equal to or lower than pre-determined amounts and the doors(7 and 31) are unlocked and all the valves(53a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,r,s,t) are closed. By the above operation, the textiles articles and the like in the container(10) is effectively dewrinkled, smoothed, dried, dehumidified and cooled by the invented automatic ironing machine in accordance with the invented method.

It can be seen, therefore, that the present invention provides a unique method for ironing the textile items and the like which effectively dewrinkles clothes by applying humidity, heat and pressure without touching the articles to be ironed by any part of the apparatus or tool like means to provide an additional tension on the clothes during ironing process and without using any other means for stretching such as clamps or cords or inflatable bags and the like. Although the present invention has been described with reference to a specific embodiment, it should be pointed out that changes, modifications, variations, and additions for improvement may be made without departing from the scope and the spirit of the invention as it is defined in the accompanying claims.

Industrial Applicability

The present invention can easily be applied to technology with the existing methods of production as used in automatic washing machines, dishwashers, and air conditioners.